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Hints on Writing Technical Papers
and Making Presentations

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Abstract— **This paper is an attempt to give some guidelines on how to write a good technical paper and to make good presentations, important skills for a successful career in research and teaching.**

Index Terms—**Technical presentation, technical writing, thesis presentation.**

I. INTRODUCTION

I have been involved in a career in research and teaching for 17 years. During this period, I have had the opportunity to work very closely with some very bright Ph.D. students.[1] One of the major problems that they ran into, as I myself ran into earlier in my career, is how to communicate effectively. Over the years, my own techniques have improved. This was achieved by reading books on the subject, talking to colleagues, and above all, observing and studying the techniques of those considered good writers and good speakers in the research community. In this paper, I will summarize my findings.

In the next section, the structure of a technical paper is described. Section III contains hints on making good presentations, and Section IV, the conclusion. Hints on the thesis defense are included in Appendix A. Some common writing pitfalls are included in Appendix B.

II. STRUCTURE OF A TECHNICAL PAPER

A technical paper should be clear and concise. The goal is to convey ideas and results to the readers in the least possible time and space. The notations and format should be consistent throughout the paper. A paper usually consists of the following components:

1) Title—It should be concise and to the point. For example, some publications limit the title to less than ten words.
2) Abstract—A summary of the paper, including a brief description of the problem, the solution, and conclusions. Do not cite references in the abstract.

[1] The primary audience of this paper was originally my Ph.D. students. I am glad to report that the time I have spent in preparing this paper has been more than offset by the savings in time I would have had to spend correcting their writing. A colleague suggested that I submit this paper for publication since other engineering educators may find it useful.

3) Keywords—They should be selected such that a computerized search will be facilitated.
4) Introduction—This should contain the background of the problem, why it is important, and what others have done to solve this problem. All related existing work should be properly described and referenced. The proposed solution should be briefly described, with explanations of how it is different from, and superior to, existing solutions. The last paragraph should be a summary of what will be described in each subsequent section of the paper.
5) System Model—The proposed model is described. There will invariably be assumptions made. State the model assumptions clearly. Do the assumptions make sense? Sometimes it will be necessary to introduce assumptions to make the problem mathematically tractable, but they should at least reflect some real-world situations. Thus while the proposed assumptions may not hold in general, there should at least be some instances where they will hold and hence the model and conclusions drawn will apply. Use figures to help explain the model.
6) Numerical results—Based on the model, numerical results will be generated. These results should be presented in such a way as to facilitate the readers' understanding. Usually, they will be presented in the form of figures or tables. The parameter values chosen should make sense. They should preferably be taken from systems in the real world. If that is not possible, they may correspond to those values for which published results are available so that one can compare these results with existing ones. All the results should be interpreted. Try to explain why the curves look the way they do. Is it because of the assumptions, or because the system behaves that way? In most cases, a simulation model is required to validate the system model with the assumptions. In that case, it is important to not only show the average values of the simulation results, but also confidence intervals. A number of books on modeling techniques will show how confidence intervals may be obtained. In addition, it is very important to explain what is being simulated. I once attended a thesis defense in which the candidate claimed that his analytical results matched the simulation results perfectly. I then found that he had basically simulated the analytical model, using the same assumptions! Details on the simulation time, the computer, and the language used in the simulation should also be included.

7) Conclusions—This summarizes what have been done and concluded based on the results. A description of future research should also be included.

8) References—This should contain a list of papers referred to in the paper. If there is a choice, use a reference which is more readily available, i.e., if an author has published a conference version and a journal version of the paper, refer to the journal version. Research reports, internal memos, private correspondences, and preprints are usually hard to access and should be avoided as much as possible. By the way, journal editors tend to pick reviewers from the authors of the references cited in the submission.

9) Appendix—Those materials which are deemed inessential to the understanding of the paper, but included for the sake of completeness. Sometimes, detailed mathematical proofs are put in the appendix to make the paper more readable.

10) Figures—The figures may be placed immediately after they are referred to in the text, or placed at the end of the paper. Each figure should be readable without relying on the accompanying description in the text. Thus, all symbols used in the figure should be explained in the figure legend. In addition, do not make the figures and legends too small. Some figures may be reduced by the publisher before they are printed, and one should ensure that the figures are still legible after reduction.

III. PRESENTATIONS

Good presentation skill is another prerequisite of a successful researcher. Good ideas will not be recognized unless they are effectively conveyed to others. The presentation should be rehearsed. This will help determine how many slides should be included in the presentation. A good rule of thumb is one slide per minute of presentation, although that depends on the individual speaker and the contents of the slide. Friends can be invited to the rehearsal, to ask questions, and to give suggestions for improvements. Some other points to note are:

1) Visit the venue of the presentation before the talk to get familiar with the layout of the room, and with the presentation equipment.

2) Do not dive into the viewgraphs immediately. Establish rapport with the audience by speaking to them for a couple of minutes before turning on the projector. What does one talk about? One can summarize the results; explain how this talk relates to other talks in the session; or how it relates to the keynote speech of the conference; or even tell a story of how one got interested in this particular research topic, etc. Of course, this cuts into valuable presentation time, and should not be overdone. This will get the audience to focus on the speaker, rather than on the screen.

3) Maintain eye contact with the audience throughout the talk. Talk to the audience, not to the viewgraphs. Address different parts of the room as the talk progresses. This means that the room should remain lit. Most overheads will still be readable with the room lit. It is a bad idea to speak in a dark room in which the only thing visible is the screen. The contact with the audience will be lost.

4) Make sure the visual aids are readable. There are now a large number of presentation tools available, ranging from handwritten transparencies to multimedia presentations. The most popular one is still transparencies projected onto a screen using an overhead projector. To determine if a transparency will be readable, the following test can be used. Put the transparency on the floor. It should be readable while the reader is standing. Using a bit of color to highlight important points is useful, although color transparencies are more expensive. With the increasing popularity of video projectors, it is expected that most presentations in the future will be made using a notebook PC connected to a video projector. It will be a good idea, however, to bring transparencies as a backup.

5) Do not put too many ideas on the same transparency. The audience should be focusing on what the speaker has to say, rather than desperately trying to read the transparency.

6) Everything on the slide should be explained.

7) The presentation does not have to follow the paper exactly. In a conference, 25 min will normally be allocated to each speaker, with 20 min for presentation and five minutes for questions and answers, and there is no way to include all the details of the paper. The goal should be to explain the importance of the work, the key ideas of the solution, and how it is different, and hopefully, better than existing solutions. If the audience is interested, the paper is available in the conference proceedings. I have attended a presentation in which the speaker just made transparencies of the paper and read the transparencies. Needless to say, this is unacceptable.

8) On the other hand, the presentation should not deviate too much from the paper either. I once attended a presentation in which the speaker said that the paper in the proceedings described old results, and then proceeded to deliver an altogether different paper. While this may be acceptable for informal workshops, it is not appropriate for conferences in which all of the submissions have been formally reviewed.

9) Do not put too much mathematics on the slides. It is usually difficult to follow detailed mathematical derivations during a 20-min presentation. Just enough mathematics should be presented to bring the key points across. The focus of the talk, in general, should be on the results. Use figures (plots) to bring the points across.

10) There will usually be questions at the end of the presentation. In fact, a good session chair will usually prepare a couple of questions in advance just in case there are no questions from the audience. Some of these questions will hopefully have already been asked during the rehearsal, and should be handled very well. If there is difficulty with a particular question, do not be overly defensive. While there may be showoffs who deliberately make very critical remarks just to show how good they are, in general most people are

just trying to be helpful, and perhaps have not really understood some key points of the presentation. If forced into a corner, and the session chair does not come to the rescue, one can escape by suggesting that, due to the lack of time, the discussion will be continued during the coffee break. Alternatively, a particularly difficult question posed by the audience can be turned into an idea for future work. By the way, it is always a good idea to repeat the question so the audience knows what is being asked. This will also ensure the question is understood.

11) It is a good idea to have a slide entitled "Contributions," especially in an interview presentation. I have been to many interview talks at the end of which I was not sure what the speaker's own contributions were. Never leave an interview committee in doubt about the nature of the contributions.

IV. CONCLUSIONS

Some thoughts on how to write good technical papers and make good presentations are included in this paper. Hopefully, this will help the reader communicate ideas and results to the research community more effectively.

APPENDIX A
THESIS DEFENSE

During the defense, the committee is going to look for:

1) whether the candidate has a very good understanding of the problem. That means one should be conversant in the relevant literature, and should explain how the proposed approach is different and better than existing work. In addition, be ready to discuss how practical the work is, i.e., is it just an academic exercise or can one actually use it in the real world? Are the assumptions realistic?

2) the contribution to the research community. This should be described in the abstract of the thesis, and repeated in the conclusions. There should be at least one slide entitled "Contributions" in the defense presentation.

3) whether the candidate has taken the time to digest the results generated. That is, whenever results are shown, such as a plot, or a table, be prepared to interpret the results. An intuitive explanation of why the results look a particular way is especially helpful. If there are simulation results, explain what is being accomplished with the simulation, e.g., to justify a certain assumption in the analytical model. Be sure to have explanation for results which look strange, such as a curve which is not smooth, or a table with sudden jumps in values.

4) suggested future work. List a few possible directions. Describe possible approaches to these problems, i.e., demonstrate that these problems have been thought through.

APPENDIX B
COMMON ERRORS

Over the years, I have collected a list of common mistakes:

1) Hyphenated words—If the first word is used as an adjective, no hyphen is necessary, e.g., first generation.

If the first word is a noun, then you need to hyphenate, e.g., range-limited. If the second word is a gerund, i.e., the present continuous tense of a verb, then it is not necessary to hyphenate, e.g., cell splitting.

2) Normally, integers less than ten are spelled out. Thus one will write "six cells" instead of "6 cells." Integers larger than ten and fractional numbers are written in arabic digits, i.e., 12, 5.6, etc. Fractional numbers are considered plurals. Thus, we will say "one meter," but "0.5 meters."

3) In technical papers, there are usually symbols, and the question arises as to which article to use in front of symbols. Should we say a M/M/1 queue or an M/M/1 queue? The rule is the same as in regular writing without symbols, i.e., if the word starts with a vowel, namely, the letters a, e, i, o, u, you will use the article "an"; otherwise, you will use "a." However, we need to determine how the symbol is pronounced. In the case of M/M/1, we pronounce it "em-em-one," i.e., it starts with a vowel. Therefore, "an M/M/1" is correct. Compare this with a B-ISDN network. In this case, the B in B-ISDN is pronounced like "bee," i.e., not a vowel.

4) The first time a symbol is used, explain what it means, usually with the symbol in brackets, e.g., one will write "Integrated Services Digital Network (ISDN)." Subsequently, use the symbol only. This is in keeping with the concept of conciseness.

5) Try avoiding negative words like "not," "un," "non," etc., as well as double negatives such as "not invalid," "not uninteresting" as much as possible. For example, use "invalid" instead of "not valid," use "violating" instead of "not satisfying."

6) The phrase "a lot of" is used for uncountable objects, such as a lot of money. Do not use it for countable objects, use the word "many" instead, i.e., say "many users" rather than "a lot of users." The same goes for "a large amount." It is also used for uncountable objects.

7) Say "greatly improves" rather than "highly improves" or "largely improves."

8) Say "contrary to" rather than "in contrary to." "Contrary to" is the same as "in contrast to" or "as opposed to."

9) The words "work" and "research" are already in plural form. Thus we do not say "Existing works in this area ...," or "Prior researches ..."

10) Do not use abbreviated forms like "don't." They should be spelled out.

11) Avoid using multiple superlatives. Use "best" rather than "very best," "optimal" rather than "most optimal."

12) The words "figure," "table," "theorem," "lemma," etc. may be used as proper or common nouns. Proper nouns must be capitalized. They are proper nouns when a number or some other attribute follows them. For example, we say, "Fig. 1 illustrates ...," and "In this figure, we illustrate ...."

13) Do not start a sentence with "also." Use words such as "Besides," "Moreover," "In addition" instead.

14) Say "comprises" or "consists of" rather than "comprises of."

15) Semi-colons can be used to break up groups of objects. For example, "Set A comprises numbers 1, 2, 3; Set B comprises 4, 5, 6; Set C comprises 7, 8."

16) Avoid repeated usage. Say "... the storage required in the first case is greater than that in the second case," rather than "... the storage required in the first case is greater than the storage required in the second case."

17) English and American spelling is sometimes different, i.e., "colour" versus "color." Try to be consistent throughout the text.

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